Science with a Mission

Advancing the Energy, Economic, and National Security of the United States

PROGRAM OFFICES

The Department of Energy's Office of Science is the single largest supporter of basic research in the physical sciences in the United States. It oversees – and is the principal Federal funding agency of – the Nation's research programs in high energy physics, nuclear physics, and fusion energy sciences.

The Office of Science sponsors fundamental research programs in basic energy sciences, biological and environmental sciences, and computational science. In addition, the Office of Science is the Federal Government's largest single funder of materials and chemical sciences, and it supports unique and vital parts of U.S. research in climate change, genomics, life sciences, and science education.

"We will restore science to its rightful place.... We will harness the sun and the winds and the soil to fuel our cars and run our factories.... All this we can do. All this we will do."

> President Barack Obama
> Inaugural Address
> January 20, 2009

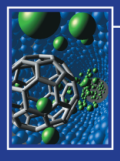
The Office of Science manages this research portfolio through the following interdisciplinary program offices, with these goals and areas of research:

> OUR PROGRAMS AND GOALS

ADVANCED SCIENTIFIC COMPUTING RESEARCH

Deliver Computing for the Frontiers of Science

> Computer science and software research
> Extending science through computation and collaboration
> Supercomputing technologies for science
> Computational and network infrastructure and tools



BASIC ENERGY SCIENCES

Advance the Basic Sciences for Energy Independence

> Materials sciences and engineering research
> Chemical sciences, geosciences, and physical biosciences research
> Nanoscale science, engineering, and technology research
> Scientific user facilities to understand materials and perform nanoscale science

BIOLOGICAL AND ENVIRONMENTAL RESEARCH

Harness the Power of Our Living World

> Bioenergy research
> Genomics and low dose radiation research
> Climate change research
> Environmental remediation sciences
> Medical sciences

FUSION ENERGY SCIENCES

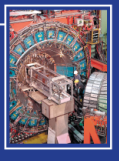
Bring the Power of the Stars to Earth

> Harnessing fusion energy through basic research in plasma and fusion sciences
> ITER, the international burning plasma experiment

HIGH ENERGY PHYSICS

Explore the Fundamental Interactions of Energy, Matter, Time, and Space

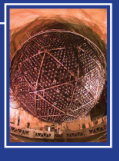
> Explore unification of the forces and particles of nature
> Understand the cosmos and the destiny of the universe
> Develop the tools for scientific revolutions to come



NUCLEAR PHYSICS

Explore Nuclear Matter – from Quarks to Stars

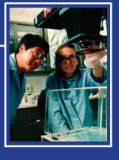
> Studies of hot, dense nuclear matter
> The quark structure of matter
> Nuclear structure/astrophysics, fundamental symmetries, and neutrinos



WORKFORCE DEVELOPMENT FOR TEACHERS AND SCIENTISTS

Train the Next Generation of Scientists and Engineers to Maintain U.S. Scientific and Technological Leadership

> Student internships at national laboratories
> Fellowships for distinguished science, technology, engineering, and mathematics educators
> The DOE National Science Bowl® for high school and middle school students



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RESEARCH UNIVERSITIES

The Department of Energy's Office of Science supports a diverse portfolio of research at colleges and universities across the United States.

We balance our signature support for big science and interdisciplinary teams with investments in research projects conducted by leading university and laboratory investigators.

About half the users at Office of Science user facilities are from colleges and universities, providing important resources to their researchers.

In addition, about a third of Office of Science funding goes to support research at more than 300 colleges and universities nationwide, as the map below highlights.

WORKFORCE DEVELOPMENT

The Office of Science has played a fundamental role in training America's scientists and engineers for more than 50 years. Today we offer a range of workforce development programs for teachers and scientists to help ensure this Nation has the scientific workforce it will need in the twenty-first century.

The Office of Science sponsors undergraduate student internships at national laboratories and fellowships for distinguished science, technology, engineering, and mathematics educators.

Faculty sabbatical fellowships also are available for faculty from minority serving institutions to collaborate on research projects at national laboratories.

DOE NATIONAL SCIENCE BOWL®

The Department of Energy's national laboratories conduct some of the most sophisticated research and development in the world. We therefore have a keen interest in encouraging America's youth to study and pursue careers in science.

The Office of Science reaches out to America's youth in grades K-12 and their teachers to help improve students' knowledge of science and mathematics and their understanding of global energy and environmental challenges.

To attract and encourage students to choose an education in the sciences and engineering, the Office of Science also manages the DOE National Science Bowl. At these educational events, high school and middle school students solve technical problems and answer questions in all branches of science and mathematics.

Since the National Science Bowl program began in 1991, it has brought together more than 130,000 high school and middle school science and mathematics students– as well as their teachers – from across the country. DOE's Office of Science launched the National Science Bowl for middle school students in 2002.

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NATIONAL LABORATORIES

The Department of Energy's Office of Science is the steward of 10 world-class laboratories with unmatched capabilities for solving complex interdisciplinary scientific problems.

These laboratories are often called the "crown jewels" of our national research infrastructure. The DOE national laboratory system is the most comprehensive research system of its kind in the world – and the backbone of American science.

The Office of Science national laboratories perform research and development that is not well suited to university or private sector research facilities because of its scope, infrastructure, or multidisciplinary nature – but for which there is a strong public and national purpose.

A high level of collaboration among all of the national laboratories in the use of unique scientific equipment and supercomputers, facilities, and multidisciplinary teams of scientists increases their collective contribution to the Department of Energy and the Nation, making the laboratory system more valuable as a whole than the sum of its parts.

THE 10 DOE OFFICE OF SCIENCE NATIONAL LABORATORIES

AMES LABORATORY

LAWRENCE BERKELEY NATIONAL LABORATORY

ARGONNE NATIONAL LABORATORY

OAK RIDGE NATIONAL LABORATORY

BROOKHAVEN NATIONAL LABORATORY

PACIFIC NORTHWEST NATIONAL LABORATORY

FERMI NATIONAL ACCELERATOR LABORATORY

PRINCETON PLASMA PHYSICS LABORATORY

THOMAS JEFFERSON NATIONAL ACCELERATOR FACILITY

SLAC NATIONAL ACCELERATOR LABORATORY

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USER FACILITIES

The Department of Energy's Office of Science builds and operates the world's finest suite of scientific facilities and instruments that researchers depend on to extend the frontiers of science.

In the 2007 fiscal year, these facilities were used by more than 21,000 researchers from universities, national laboratories, private industry, and other federal science agencies.

These very large and complex machines and instruments have enabled U.S. researchers to make many of the most important scientific discoveries over the past six decades, with spin-off technological advances creating entirely new devices and industries.

The Office of Science's state-of-the-art facilities are located at national laboratories and universities, open to researchers on a peer-reviewed basis, shared with the science community worldwide, and feature technologies and capabilities that are available nowhere else.

20-YEAR FACILITIES OUTLOOK

The health and vitality of U.S. science and technology depends upon the availability of the most advanced research facilities.

Facilities for the Future of Science: A Twenty-Year Outlook listed 28 new large scientific facilities and upgrades of current facilities that will define scientific opportunities across all fields of science supported by DOE over the next 20 years.

Investment in these facilities will yield extraordinary scientific breakthroughs – and vital societal and economic benefits.

The $1.4 billion Spallation Neutron Source (SNS) at Oak Ridge National Laboratory, the largest civilian science project in the U.S., was completed in 2006 on time and on budget. The SNS will provide the most intense pulsed neutron beams in the world for scientific research and technology development.

WHAT DISTINGUISHES THE DOE OFFICE OF SCIENCE?

The Office of Science fills a unique and central role in the Nation's scientific endeavor. Our work is complementary to that of other government research agencies.

We distinguish ourselves by our emphasis on research that:

> is driven by the Department of Energy missions,
> takes the long view,
> is open and interdisciplinary,
> requires the use of large-scale facilities, and
> takes risks commensurate with the high pay-offs we expect.

OUR FACILITIES

The DOE Office of Science facilities include:

> particle accelerators,
> synchrotron light sources,
> neutron scattering facilities,
> nanoscale science research centers,
> supercomputers,
> high-speed networks, and
> genome sequencing facilities.

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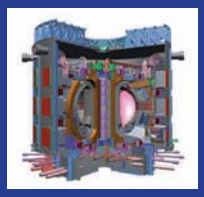
OUR PRIORITIES

The research priorities of the Department of Energy's Office of Science flow from our long-term strategic goals and reflect our Nation's commitment to energy security, a cleaner environment, improved health care, greater economic prosperity, and intellectual leadership.

Pursuing these research priorities over the next five to 10 years and beyond will be challenging, but they hold enormous promise for the future of our Nation and the overall well-being of our citizens.

ITER FOR FUSION ENERGY



ITER is an international collaboration to build the first fusion science experiment capable of producing a self-sustaining fusion reaction, called a "burning plasma." It is the next essential step on the path toward demonstrating the scientific and technological feasibility of fusion energy.

The President has made achieving commercial fusion power the highest long-term energy priority for our Nation.

SCIENTIFIC DISCOVERY THROUGH ADVANCED SCIENTIFIC COMPUTING

Scientific computing at DOE Office of Science national laboratories and user facilities enable scientists to use quantum calculations to understand the combustion process, model thermal reactions, analyze climate change data, reveal chemical mechanisms of catalysts, and study the collapse of a supernova.

Extraordinary advances in computer architecture and software design are making scientific computing a true third pillar of discovery, joining theory and experiment as a standard tool that researchers rely upon to make scientific progress.

NANOSCALE SCIENCE FOR NEW MATERIALS AND PROCESSES

The DOE Office of Science has built five new DOE Nanoscale Science Research Centers to provide the Nation's research community with world-class resources for the synthesis, processing, fabrication, and analysis of materials at the nanoscale.

Large and complicated structures can be designed, one atom at a time, for desired characteristics such as super-lightweight and ultra-strong materials. The Office of Science will help lead this revolution – with nanoscale research in materials sciences, physics, chemistry, biology, and engineering – and tools that can probe and manipulate matter at the atomic scale.

TRANSFORMATIONAL SCIENCE FOR BIOFUEL BREAKTHROUGHS

The DOE Office of Science has established three new DOE Bioenergy Research Centers, as part of its Genomics: GTL program, to accelerate basic research on plants and microbes toward the development of cost-effective means to produce cellulosic ethanol and other plant fiber-based biofuels.

Scientists at these multidisciplinary centers are marshalling the latest advances in biotechnology and genomics-based systems biology to achieve the transformational scientific breakthroughs needed to tap this abundant, renewable, and potentially carbon-neutral source of energy.

DOE Bioenergy Research Centers

DARK ENERGY AND THE SEARCH FOR GENESIS

How the universe originated – its genesis – is one of the great mysteries of science. So is "dark energy," which dominates today's universe.

The DOE Office of Science is conducting experiments at its accelerators to determine whether the complex patterns of particles and forces we observe today arose from a much simpler universe at the extremely high energies that prevailed in its first moments.

The Office of Science also is working to solve the mystery of dark energy, which makes up more than 70 percent of the universe and evidently causes its accelerating expansion.

Quantum Universe: The Revolution in 21st Century Particle Physics, a report jointly commissioned by the Office of Science and the National Science Foundation has identified the most compelling questions facing contemporary particle physics research and outlined a program to address them.

NUCLEAR MATTER AT THE EXTREMES

The DOE Office of Science is conducting experiments at Brookhaven National Laboratory's Relativistic Heavy Ion Collider to study brief, submicroscopic samples of hot plasma of free quarks and gluons that filled the universe at the age of one microsecond.

New studies are planned to explore the extremes of nuclear matter and the processes that form nearly all of our chemical elements in stars and supernovae.

Understanding how nuclear matter is formed is critical to understanding the processes within stars and how elements are created – including possible new elements at high-energy densities and the extreme limits of stability.

RESEARCH FACILITIES FOR THE FUTURE OF SCIENCE

Just as very large and complex machines and instruments have enabled U.S. researchers to make many of the most important scientific discoveries over the past six decades, the discoveries of the future will require powerful next-generation scientific tools.

In *Facilities for the Future of Science: A Twenty-Year Outlook*, the DOE Office of Science proposed a portfolio of 28 prioritized new scientific facilities and upgrades of current facilities spanning the scientific disciplines to ensure the U.S. retains its primacy in critical areas of science and technology well into the next century.

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OUR LEGACY

The Department of Energy's Office of Science is heir to the revolutionary work of Albert Einstein, Enrico Fermi, and E.O. Lawrence.

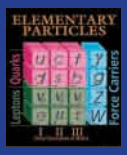
The Office of Science makes history every day because we sustain their tradition of innovative basic scientific research that improves people's lives.

As testimony to the high quality and impact of the research DOE underwrites, more than 80 Nobel Laureates have been supported by or affiliated with the Department of Energy and its predecessor agencies.

The Office of Science has a vital tradition of funding fundamental research that focuses on critical national challenges – and produces important scientific breakthroughs and contributes to our Nation's well-being.

FACILITIES FOR DISCOVERY

Supported the construction and operation of accelerators, from cyclotrons to light sources to colliders, for fundamental research; these are used for a wide range of applications, such as fabricating semiconductors and microchips, studying the structure of viruses, and designing new drugs

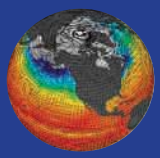


QUARKS AND LEPTONS

Sponsored research leading to the discovery of quarks and leptons, the most fundamental constituents of matter, resulting in 13 Nobel Prizes

MEDICAL DIAGNOSIS AND TREATMENT

Helped develop new tools for the non-invasive diagnosis and treatment of disease, including PET scans, MRIs, and nuclear medicine cancer therapies

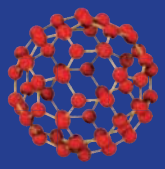


CLIMATE CHANGE SCIENCE

Launched the first research program in the U. S. to study climate change in 1978; using computer software and systems that model and simulate environmental conditions and project climate change under varying emissions scenarios

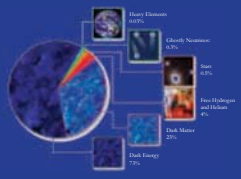
BASIC RESEARCH IN SUPPORT OF THE HYDROGEN ECONOMY

Conducted a workshop in 2003 to determine the basic research required to turn the promise of a hydrogen economy into a reality; now the Office of Science is funding an innovative long-range program of basic research, coupled and coordinated with applied programs, to achieve critical revolutionary breakthroughs in hydrogen production, storage, and use



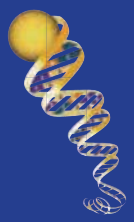
A REVOLUTION IN CARBON CHEMISTRY

Supported the 1996 Nobel Prize-winning discovery of a new form of carbon, the buckminsterfullerene or "buckyball," which has spurred a revolution in carbon chemistry and can be manipulated to produce superconducting salts, new three-dimensional polymers, new catalysts, and biologically active compounds



DARK ENERGY

Funded research leading to the discovery that about 70 percent of the universe is composed of "dark energy," an unidentified form of energy not included in the Standard Model, physicists' current theory of matter and the forces of nature – and that the expansion of the universe is accelerating, rather than slowing due to gravity as expected

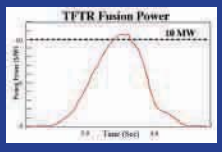


PIONEERING THE HUMAN GENOME PROJECT

Launched the human genome program in 1986 and developed the cost-effective DNA sequencing and computational technologies that made it possible to finish the "book of life" in 2003; also founded the DOE Joint Genome Institute, which completed the sequencing of three of the human genome's chromosomes – numbers 5, 16, and 19 – which together contain some 3,300 genes, including those implicated in forms of kidney disease, prostate and colorectal cancer, leukemia, hypertension, diabetes, and atherosclerosis

DETECTING NEUTRINOS

Sponsored research resulting in the Nobel Prize-winning detection of atmospheric and solar neutrinos, which in turn led to research determining that the mysterious elementary particles have mass and oscillate among three "flavors" as they travel through space



A FUSION SCIENCE MILESTONE

Produced a record 10.7 million watts of fusion power at the Princeton Plasma Physics Laboratory's Tokamak Fusion Test Reactor in 1994, an outcome promoting fusion as an attractive energy source; if converted to electricity, the amount of fusion power produced in the experiment would be enough to meet the needs of 3,000 average-sized homes

RESTORING SIGHT—AND MORE

Sponsoring research and development of an artificial retina, which can restore sight in blind patients with macular degeneration, retinitis pigmentosa, and other eye diseases; the technology that is being developed in the artificial retina project may be adapted to help persons with spinal cord injuries, Parkinson's disease, deafness, and almost any other neurological disorders

Office of Science

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